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THE IDENTITY OF *GobiUS AFFINIS* KOLOMBATOVIC,
WITH NOTES ON THE SYSTEMATICS AND BIOLOGY OF
POMATOSCHISTUS PICTUS (MALM) (PISCES: GOBIIDAE)

INTRODUCTION

Among new species of Adriatic gobies (Teleostei: Gobiidae) described from the Dalmatian coast by KOLOMBATOVIC (1891), the "*Gobius affinis*" of this author has remained an enigma to subsequent workers on the systematics of this critical group of fishes. Under the name of *G. affinis*, but without further conventional description, SANZO (1911) recorded the cephalic sensory papillae and lateral-line pores of a goby possessing a suborbital row *a*, short row *c*, no transverse suborbital rows, and a canal system with the normal complement of pores (SANZO, 1911, figs. 9,10). Later, DE BUEN (1923) employed the name for a species-group of European gobiids comprising merely *G. reticulatus* Valenciennes, 1837, with which DE BUEN concluded that *G. affinis* was synonymous. In fact, neither name is available as a senior synonym in combination with *Gobius* L. because both were preoccupied when first published (see below). ILJIN (1930) made *G. affinis* Kolombatovic (*sensu* SANZO, 1911) the type-species of a new genus, *Buenia*, to house in addition the north-eastern Atlantic *G. jeffreysii* Günther, 1867. The sensory papillae and canal system of *B. jeffreysii* shown by MILLER (1963a, fig. 21) certainly bear a close resemblance to those of the species originally studied by SANZO (1911). However, both NINNI (1938) and CAVINATO (1952), adopting a tentative suggestion by DE BUEN (1923), relegated *G. reticulatus* and *G. affinis* to the synonymy of *G. marmoratus* (Risso, 1810), which may be assigned to the genus *Pomatoschistus* Gill (MILLER, 1968). As a member of this genus, *P. marmoratus* has a well developed row *a*, with usually a single transverse series (*atp*) from this, in addition to several transverse suborbital series derived from row *c* (CAVINATO, 1952, fig. 4), and, by these features, is easily differentiated from the species of *Buenia*.

Recently, the author has examined syntypes of both *G. reticulatus* Valenciennes (Museum d'Histoire Naturelle, Paris, A 1247) and *G. affinis* Kolombatovic (Naturhistorisches Museum, Vienna), and can confirm that the former species is *Pomatoschistus marmoratus* (Risso) (MILLER & BAUCHOT, in preparation). However, fifteen syntypes of *G. affinis*, from Split (NHMW 28663-670) and the neighbouring port of Vranjic (NHMW 28671-676), belong neither to *Buenia* nor to *P. marmoratus* but seem referable to the north-eastern Atlantic *P. pictus* (Malm, 1865), the "painted goby" of English authors. Apart from general correspondence in lateral-line system and meristic values, the types of *G. affinis* all show the distinctive rows of black spots on the first and second dorsal fins, prominent pale saddle-like markings across the back descending to the lateral midline on each side, and other features of pigmentation which characterise *P. pictus*. The original account of *G. affinis* by KOLOMBATOVIC alludes to dark spots on the dorsal fins and to "saddles" but by itself does not permit satisfactory identification with *P. pictus*. Minor differences between these Adriatic specimens and more northern *P. pictus* include consistently lower mean values for radial formulae and scale counts, significant statistically for anal fin-ray and lateral scale numbers; slight disparity in certain body proportions; and more frequent accentuation of second dorsal spots in the Adriatic fishes (Plate I). It has therefore been decided to place the latter in a separate new subspecies of *P. pictus*, described below.

Solving the problem of *G. affinis* raises other nomenclatural questions about the species which SANZO (1911) studied under this name and whose pattern of sensory papillae is quite different from that of *P. pictus*. Although *B. jeffreysii* is currently believed to inhabit only the north-eastern Atlantic, it is possible that this species occurs also in the Mediterranean and may be that encountered by SANZO (1911) and by FAGE (1918), who records meristic characters and coloration in small Aegean examples comparable to those displayed by *B. jeffreysii*. However, since DE BUEN (1930) was able to distinguish *B. jeffreysii* from a Mediterranean form (termed *B. reticulatus*), albeit on rather tenuous criteria, the latter population may represent a valid species. If so, the name of this taxon must become *Buenia affinis* Iljin, 1930. This situation arises because, in founding *Buenia*, Iljin (1930) cited *Gobius affinis* Kolombatovic as the type-species on the basis of SANZO's (1911) description of a lateral-line system which does not in fact belong to the real *G. affinis* Kolombatovic. Under these circumstances, covered

by Article 70 (b) (i) of the International Code (INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1961), the type-species of *Buenia* must be interpreted as that actually before ILJIN (i.e. the species to which SANZO's description applied), not the species originally described by KOLOMBATOVIC, and ILJIN may be «considered to have established a new nominal species, with the same specific name as the misidentified species, in the new nominal genus».

Pomatoschistus pictus is a small inshore teleost of gravel or sandy deposits, common in the temperate north-eastern Atlantic from Norway to northern Spain (MILLER, 1963b; LOZANO Y REY, 1960). The fish derives its specific name from the attractive rose-red banding and intense dark spots along the dorsal fins (HOLT & BYRNE, 1903, Pl. II, 1; LYTHGOE, 1971, Pl. 117). There are previous records of *P. pictus* from the Mediterranean faunistic region, by NINNI (1938) for the Lagoon of Venice, by SÖZER (1941) and ERAZI (1942) from the Sea of Marmora, and, in the Black Sea, by ILJIN (1927), who obtained two specimens off Anapa. CAVINATO (1952) regarded the Venetian *Gobius pictus* of NINNI as *P. microps* (Kroyer, 1838). However, the material termed *G. microps* by CAVINATO probably embraces two species of the Ponto-Caspian genus *Knipowitschia*, *K. panizzeae* (Verga, 1841) and *K. caucasica* (Kawrajsky, in BERG, 1916), only recently recognised in the Adriatic (MILLER, 1972). CAVINATO's suggestion that *P. microps* and *P. pictus* are conspecific is certainly untenable. The male example of *P. pictus* figured by NINNI (1938, Tav. VI, *d*) appears to be correctly identified, although the pair comprising Tav. VI *g* and *h* do not show the features of this species. In commenting on dorsal fin coloration, NINNI erroneously describes the red banding as below the row of dark spots. Recently, four examples of *P. pictus* have been received from Muggia, near Trieste, in the extreme north of the Adriatic, and confirm the presence of this species in the region studied by NINNI (1938). These fishes are similar to the individuals from Split and may be assigned to the new subspecies. It is evident, from the elongate second spinous dorsal ray and scaled nape of the fish which SÖZER identified as *G. pictus*, that his 1941 record (and probably that by ERAZI, 1942) for the Sea of Marmora applies to another species, perhaps *Deltentosteus quadrimaculatus* (Valenciennes 1837). By coincidence, five specimens of *P. pictus*, identical with the Adriatic fishes, have now been collected by Dr. H. Bath at Erdek, in the Sea of Marmora. Consequently, it may be speculated that the subspecies occurs also in at least the Ionian and Aegean

Seas, although such a hypothesis need not be necessarily valid. Eastward spread from the Sea of Marmora into the Black Sea may be prevented by the markedly lower salinity of the latter, although other Mediterranean gobies of coastal habitat have colonised the Black Sea in post-glacial times (MILLER, 1965). However, the Black Sea record of *G. pictus*, doubtfully identified by ILJIN (1927), remains to be confirmed (SVETOVIDOV, 1964). To date, therefore, only Adriatic and Marmora records are fully corroborated.

Although DUNCKER (1928) correctly believed that DE BUEN's (1923) "Atlantic race" of "*Gobius microps laticeps*" from Vigo was *G. pictus*, the corresponding Mediterranean race recognised by DE BUEN (1923) seems to have been *P. marmoratus* (with which *G. ferrugineus* Kolombatovic, 1891 is synonymous), not *P. pictus*. The true *G. laticeps* Moreau, 1881 has now been found to be *P. microps* by the present author, who has examined MOREAU's holotype of the former species preserved in the Museum d'Histoire Naturelle, Paris.

SUBSPECIES WITHIN *Pomatoschistus pictus*

The decision to recognise the Mediterranean specimens as belonging to a separate subspecies from the eastern Atlantic form is based on differences in the following morphological features:

i) **C O L O U R A T I O N .** Although life-coloration of the Adriatic specimens could not be studied, the impression was gained that they differed from most Atlantic *P. pictus* in possessing more melanophores in areas of the dorsal fins corresponding to the pink bands shown in living fish of the latter form. In extreme cases (Plate I) a second complete row of smaller black spots is formed above the single complete row found on the second dorsal fin of Atlantic *pictus* and even traces of a third row. In all except one of the fishes from Split, at least slight indications of such a second complete row were present, and, in two fishes, the latter was very pronounced. Among Manx examples about half displayed some melanophores in the position of a second complete row but, especially in larger adults, only a few posterior spots representing this row may be visible (Fig. 1; Plate I). However, in at least two individuals from the Isle of Man, the second complete series was as well developed as in most Adriatic fishes. In general, although tending to be more numerous, the dorsal fin spots are smaller and less intense in the Mediterranean fishes than in the Atlantic form. Otherwise,

coloration seems to be essentially the same between the subspecies except for a coarser body reticulation sometimes manifest among the Adriatic fishes because of fewer scales in lateral series.

ii) **Body Proportions.** The ratios usually employed by the author in gobiid systematics are given for each subspecies in the systematic accounts, and have been compared statistically by Student's t-test. Both sexes of the new subspecies, as represented by the Split population, differ from the typical *pictus* in tending to have more distant pelvic and second dorsal fins, longer caudal peduncles and caudal fins, deeper bodies, and narrower cheeks. In males from Split with reference to typical *pictus*, the head is longer, as well as narrower in its own length, while females have a longer abdomen but shorter pelvic disc, more distant anus, and shorter anal fin-base. Differences between the sexes in the Mediterranean subspecies, not manifest in the other, are the shorter second dorsal fin, longer caudal fin, deeper body at pelvic origin, longer abdomen, larger eye and correspondingly thinner cheek. This contrast in body proportions between the subspecies cannot be explained as resulting simply from different methods of preservation. Most of the study material used for measurements of the Atlantic subspecies has been preserved in dilute formalin for a relatively short time (not more than thirteen years) while the specimens from Split must have been kept in alcohol for at least seventy years. Despite the greater shrinkage which might be expected in the latter, these fishes have the deeper bodies and longer dimensions along the horizontal axis of the body. The body proportions determined for the other examples of *adriaticus* from Muggia and Erdek (see p. 75) largely agree with those of the Split material, except that extremes in values for distance from snout to second dorsal fin and for caudal fin length approach or overlap those for the typical subspecies.

iii) **Meristic Characters.** The number of rays in the first and second dorsal, anal, and pectoral fins, and of vertebrae (including the urostyle) has been compared between Adriatic material from Split and two British populations, sampled off Port Erin, Isle of Man, and at Looe Cornwall, on the western English Channel (see Material), representing the typical subspecies. In addition, counts of scales in lateral series (axilla to base of caudal fin) were compared for the Split and Manx gobies. Results are given in the systematic accounts below. There is considerable overlap in range of values for all characters between

the three groups. The Adriatic fishes have consistently lowest mean values, but, statistically, the western Channel population seems to differ as much from the Manx one as from the Split population. Only in lateral scale-counts do Split and Manx *P. pictus* differ to a highly significant extent, while the Cornish *pictus* are separable at this level in both anal and pectoral ray means from the two other populations, lateral scales not being counted in the former. These results suggest local meristic differentiation within smaller areas than the overall geographical territories attributed to the two subspecies. On the basis of meristic characters alone, there is little justification for distinguishing the Split material as a separate subspecies if the Looe fishes are not treated similarly, although the coloration of these Western Channel *pictus*, as far as could be determined in the mostly immature collection, was that of the typical subspecies. Because the Adriatic fishes from Split show a trend towards low counts, especially distinctive in number of anal rays and lateral scales, and expected in the warmest waters inhabited by a species, meristic evidence can play a subsidiary role in the present definition of subspecies. However, potential heterogeneity of Atlantic populations, and perhaps those in other parts of the Adriatic, may reduce its significance on further investigation. The limited number of specimens from Muggia and the Sea of Marmora have meristic features (p.75-76) similar to those of the Split material, with an implicit high proportion of low anal ray counts (1/8). It should also be noted that the question of temporal variation in any one locality has been of necessity ignored, although the three samples of *pictus* used statistically were obtained in different years (see Material, below).

As mentioned below (Discussion), by far the most important criterion in definition of these subspecies is that of second dorsal fin coloration. Here, the variation in spot number and development could have ethological significance in reproductive isolation and speciation. The occurrence of Manx individuals with at least traces of a second complete row of second dorsal spots, and their absence in an Adriatic fish, prevents elevation of the two taxa to the level of distinct species, which could be justified by more complete disparity in coloration.

The two subspecies are defined after the following species diagnosis. By the nature of the subspecies concept employed in this paper, it is not possible to place individuals with certainty in the correct subspecies on morphological criteria in the absence of locality information.

***Pomatoschistus pictus* (Malm, 1865)**

D i a g n o s i s . A species of *Pomatoschistus* Gill with eyes dorso-lateral, interorbit relatively narrow, and cheek deep; branchiostegal membrane attached to entire lateral margin of isthmus; caudal fin rounded; pelvic anterior membrane with smooth to slightly crenate free edge; no scales before origin of first dorsal fin, or on breast; both sexes with rows of large black spots and rosy bands along dorsal fins; well developed pale dorsal saddles; "double" spots along lateral midline, usually elongate ventrally; pigmented pelvic disc, breast, and branchiostegal membrane but no intense dark mental blotch in adult females; breeding males with nuptial warts along inner faces of pectoral rays; lateral-line system with pores ω and δ ; row *a* with one transverse row (*atp*); row *b* ending anteriorly behind vertical of middle of orbit; row *d*¹ doubled; row *i* single; D₁ VI (V-VI); D₂ I/8-9 (7-10); A I/8-9 (8-10); P 17-19 (16-20); scales in lateral series 34-43; vertebrae (including urostyle) 30 (30-31).

Two subspecies, *P.p. pictus* (Malm, 1865) (North-eastern Atlantic) and *P.p. adriaticus*, subsp. nov. (Mediterranean: Adriatic Sea and Sea of Marmora), distinguished thus:

Second dorsal fin with one complete row of black spots, and posterior spots of second row; frequently more anterior traces of second row; scales in lateral series 36-43; anal fin-rays usually I/9 (8-10); in standard length, caudal peduncle length 3.62-4.45; depth at anal fin 6.20-8.33; in head length, cheek depth 3.53-5.29; for males, in standard length, head length 3.94-4.33; head width 1.68-1.80 in own length; for females, in standard length, snout to anus 1.88-2.08; distance from pelvic origin to anus 4.08-4.75; depth at pelvic origin 5.30-6.58; anal fin-base 5.04-6.36; length of pelvic disc in pelvic origin to anus 0.80-1.00. Northeastern Atlantic: Trondheim to northern Spain.

...*pictus* Malm

Second dorsal fin usually with two complete rows of black spots, second (more distal) fainter, sometimes traces of third; scales in lateral series 34-40; anal fin-rays I/8-9; in standard length, caudal peduncle length 3.36-4.08; depth at anal fin 4.80-6.50; in head length, cheek depth 4.08-6.92; for males, in standard length, head length 3.64-4.00; head width 1.78-2.16 in own length; for females, in standard length, snout to anus 1.78-1.94; distance from pelvic origin to anus 3.88-4.64; depth

at pelvic origin 4.63-5.23; anal fin-base 5.75-6.50; length of pelvic disc in pelvic origin to anus 0.88-1.14. Mediterranean: Adriatic Sea and Sea of Marmora.

...adriaticus subsp. nov.

Pomatoschistus pictus pictus (Malm, 1865)

(Fig. 1; Pl. I, 1)

Gobius reticulatus Valenciennes: M'Coy, 1841: 403, nec *Gobius reticulatus* Valenciennes, 1837: 37 (Sicily), non *Gobius reticulatus* Eichwald, 1831: 77 (Odessa).

Gobius rhodopterus Günther, 1861: 16 (partim); Clarke & Roebuck, 1881: 112; Herdman & Dawson, 1902: 40.

Gobius pictus Malm, 1865: 410 (Gullmarfjärden); Winther, 1872: 218; 1874: 218; 1877: 41; 1879: 18; Malm, 1874: 380; 1877: 429, Taf. V, Fig. 3; Collett, 1875a: 163; 1875b: 56; Sundström, 1877: 232, Day, 1881: 167, pl. LIII, fig. 1; Hansson, 1881: 20; Hansen, 1883: 35, tab. VI, figs 3 & 4; Lilljeborg, 1884: 563, 595; Smitt, 1892: 244, 257, Pl. XIII, fig. 6; Holt & Byrne, 1898: 336; 1903: 54, Pl. II, fig. 1; Collett, 1902: 55; Herdman & Dawson, 1902: 40; Balfour-Brown, 1903: 616; Aflalo, 1904: 155, 159; Ehrenbaum, 1905: 95; Forrest, 1907: 448; Le Danois, 1909: 86; Farran, 1912: 19; 1915: 71; Otterström, 1912: 154, 159, fig. 78; Fage, 1914: 310, 313, figs 4 and 6, no. 3; 1915b: 22, 29; 1918: 79, 91, figs 67, 68; Petersen, 1917: 10, 14, figs 1,2; 1919: 50, 57, 61, 64, Pl. I, figs 11-15, Pl. II, figs 7-9, Pl. III, fig. 3; Lebour, 1919: 48, 60, 79, Pl. I, figs 4 and 5, Pl. II, fig. 1; 1920: 253, 258, Pl. III; De Buen, 1923: 147, 148, 151, 152, 161, 216, 248, fig. 63; Elmhirst, 1925: 14; 1926: 154; Alexander, 1932: 37; Künne, 1934: 350, Abb. 1-3; Fraser, 1935: 72, 76; Jenkins, 1936: 87, 95, 388, pl. 30; Ninni, 1938: 65, Tav. VI, a-c; Bal, 1940: 16; Jones, 1940: 30; Andersson, 1942: 83; Cavinato, 1952: 21; Newell, 1954: 349; Williams, 1954: 124; Cantacuzene, 1956: 41; Rae & Wilson, 1956: 34; Marine Biological Association, 1957: 400; Went, 1957: 18; Curry-Lindahl, 1961: fig. on p. 187, 188; Miller, 1961a: 17; Bruce et al.: 1963: 261; Fonds, 1964: 251, fig. 1; Crothers, 1966: 136; Ryland, 1969: 129.

Gobius minutus minor Heincke, 1880: 317 (part); Möbius & Heincke, 1883: 54 (part).

Gobius minutus pictus Malm: Le Danois, 1913: 83, 90, fig. 156.

Gobius microps laticeps Moreau, raza atlantica, De Buen, 1923: 247, figs 62, 64 (Vigo); 1931: 66 (non *Gobius laticeps* Moreau, 1881: 215, figs 103, 104 (St. Valéry en Caux)).

Gobius (Gobiusculus) pictus Malm: Duncker, 1928: 134, fig. 8; Marine Biological Association, 1931: 324; Moore, 1937: 240.

Pomatoschistus pictus (Malm): Iljin, 1930: 53, De Buen, 1931: 52; Bruun & Pfaff, 1950: 50; Duncker, 1960: 269, Abb. 103; Lozano y Rey, 1960: 78, 91, fig. 45; Halliday, 1964: 377; 1969: 314; Bagenal, 1965: 22; Jones & Miller, 1966: 516; Bini, 1969: 79; Lythgoe, 1971: 263, 276, Pl. 117.

Pomatoschistus (Iljinia) pictus (Malm): De Buen, 1930: 132; 1931: 65; Wheeler, 1969: 416, 424.

Pomatoschistus (Iljinia) microps forme laticeps (Moreau): De Buen, 1930: 133 (part).

Nomenclature. *Gobius rhodopterus* Günther, 1861 was introduced to replace *G. reticulatus* Valenciennes, 1837, which is preoccupied by *G. reticulatus* Eichwald, 1831, itself a synonym of *G. ophioc-*

phalus Pallas, 1814. In his account of *G. rhodopterus*, GÜNTHER drew information from both VALENCIENNES (1837) and also M'COY (1841), who described the life-coloration of a small goby from Dublin Bay as that of *G. reticulatus* Valenciennes. As noted above, the present author has found that *G. reticulatus* Valenciennes is a junior subjective synonym of *G. marmoratus* (Risso, 1810), which does not occur in the Irish Sea. It is certain from the published details of dorsal fin-markings that M'COY had before him examples of *P. pictus*. Since *rhodopterus* was specified by GÜNTHER as a replacement for *reticulatus*, there is no doubt that the former name must enter the synonymy of *P. marmoratus* and, although now known to be in part based on a species termed *pictus* by MALM some years later (1865), there is no case for adopting *rhodopterus* as a senior synonym to *pictus*. In practice, however, the name *rhodopterus* has been used by some British authors, in one case (HERDMAN & DAWSON, 1902) for records of a species later found to be *P. pictus* (see MILLER, 1961a). More recently, NORMAN (1927) employed *G. rhodopterus* as the name for a small gobiid from Lakes Menzaleh and Timsah on the Suez Canal. This species has proved to be a Mediterranean immigrant, *P. marmoratus*, after re-examination of the Suez Canal material preserved in the British Museum (Natural History).

Material. 32 males, $33.0 + 7.0$ to $46.5 +$ d. mm, and 41 females, $26.7 + 5.8$ to $42.5 + 9.0$ mm, from off Port Erin, Isle of Man (1958 to 1962) and 3 males, $38.0 + 8.5$ to $44.0 + 8.8$ mm, from Farland Point, Millport, Isle of Cumbrae (30 Sept. 1965) for general examination. 75 examples, standard lengths 16.0 to 29.5 mm, from Aldrick Bay, Isle of Man (2 Oct. 1959) and 31 others from Manx waters; and 91 examples, s.l. 15.5 to 35.0 mm, from Hannafore Point, Looe, Cornwall (20 and 22 Sept. 1964), for meristic characters.

Body Proportions. For method of measuring see MILLER, 1968. Values given for each sex are range and, in parentheses, number of observations, mean, standard error and results of t-test; differences probably significant (¹), significant (²), or highly significant (³) between sexes within this subspecies (s.d.) or between one sex and that in the other subspecies (adr.).

(a) In standard length,

(i) head length, in males $3.94-4.33$ (20, 4.14 ± 0.033 , adr.³), females $3.70-4.46$ (23, 4.10 ± 0.039).

(ii) head width, in males 6.82-7.50 (14, 7.15 ± 0.049), females 6.78-7.60 (14, 7.14 ± 0.065).

(iii) distance from snout to first dorsal fin, in males 2.67-3.00 (12, 2.90 ± 0.031), females 2.68-3.04 (13, 2.79 ± 0.025 , s.d.¹).

(iv) distance from snout to second dorsal fin, in males 1.83-1.91 (12, 1.87 ± 0.007 , adr.²), females 1.77-1.88 (13, 1.81 ± 0.010 , sd.³, adr.³).

(v) distance from snout to anus, in males 1.92-2.15 (12, 2.02 ± 0.017), females 1.88-2.08 (12, 1.93 ± 0.016 , s.d.², adr.³).

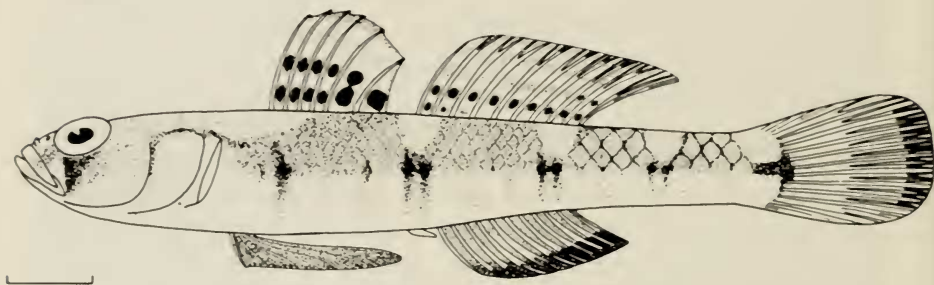


Fig. 1 - *Pomatoschistus pictus pictus*, male, based on Isle of Man example, 37.5 + 8.5 mm, trawled in Port Erin Bay, 26th July, 1962. Scale 5 mm.

(vi) distance from snout to anal fin, in males 1.74-1.83 (12, 1.80 ± 0.007), females 1.74-1.85 (13, 1.77 ± 0.009 , sd¹, adr.³).

(vii) distance from snout to pelvic fin, in males 3.41-3.74 (12, 3.57 ± 0.027 , adr.¹), females 3.21-3.87 (13, 3.52 ± 0.046 , adr.¹).

(viii) caudal peduncle length, in males 3.62-4.45 (30, 3.91 ± 0.035 , adr.³), females 3.70-4.39 (30, 3.99 ± 0.025 , adr.³).

(ix) first dorsal fin-base, in males 8.60-10.59 (12, 9.30 ± 0.199), females 7.95-11.14 (13, 9.57 ± 0.221).

(x) second dorsal fin-base, in males 4.50-5.46 (12, 4.93 ± 0.087), females 4.81-5.68 (13, 5.21 ± 0.071).

(xi) anal fin-base, in males 4.50-5.33 (12, 5.08 ± 0.065), females 5.04-6.36 (13, 5.57 ± 0.090 , sd³, adr.²).

(xii) caudal fin length, in males 4.38-5.40 (41, 4.90 ± 0.042 , adr.²), females 4.46-5.64 (33, 4.88 ± 0.043 , adr.³).

(xiii) pectoral fin length, in males 3.87-4.83 (12, 4.38 ± 0.084), females 3.96-4.82 (13, 4.36 ± 0.071).

(xiv) pelvic fin length, in males 3.51-4.69 (24, 4.08 ± 0.064), females 3.56-4.65 (19, 3.99 ± 0.059).

(xv) pelvic fin origin to anus, in males 3.87-4.83 (16, 4.47 ± 0.064), females 4.08-4.75 (15, 4.33 ± 0.049 , adr.³).

(xvi) body depth at origin of pelvic fin, in males 5.14-7.16 (22, 6.02 ± 0.106 , adr.¹), females 5.30-6.58 (23, 5.98 ± 0.075 , adr.³).



Fig. 2 - *Pomatoschistus pictus pictus*, underside of head in female, 38.5 ± 8.4 mm, trawled in Port Erin Bay, 16th Nov., 1959. Scale 1 mm.

(xvii) body depth at origin of anal fin, in males 6.20-7.68 (21, 6.92 ± 0.101 , adr.³), females 6.61-8.33 (21, 7.47 ± 0.131 , sd², adr.³).

(xviii) caudal peduncle depth, in males 9.38-11.94 (28, 10.82 ± 0.115 , adr.³), females 10.37-13.83 (30, 12.07 ± 0.169 , sd.³, adr.³).

(b) In caudal peduncle length,

(i) caudal peduncle depth, in males 2.41-3.13 (22, 2.76 ± 0.040), females 2.68-3.58 (18, 2.96 ± 0.056 , sd.²).

(c) In distance from pelvic origin to anus,

(i) pelvic fin length, in males 0.76-1.02 (16, 0.89 ± 0.023), females 0.80-1.00 (15, 0.90 ± 0.018 , adr.³).

(d) In head length,

(i) snout length, in males 4.72-6.00 (12, 5.19 ± 0.099), females 3.96-5.43 (13, 4.81 ± 0.130 , sd.¹).

(ii) eye diameter, in males 2.78-3.50 (12, 3.07 ± 0.061), females 2.79-3.45 (13, 3.03 ± 0.053).

(iii) postorbital length 1.88-2.22 (13, 2.00 ± 0.032), females 1.87-2.33 (13, 2.05 ± 0.039).

(iv) cheek depth, in males 3.53-5.29 (21, 4.36 ± 0.094 , adr.¹), females 3.72-5.00 (18, 4.46 ± 0.089 , adr.³).

(v) head width, in males 1.68-1.80 (4, 1.73 ± 0.026 , adr.²), females 1.67-1.89 (9, 1.77 ± 0.025).

(e) In eye diameter,

(i) interorbital width, in males 1.93-4.27 (11, 3.13 ± 0.212), females 2.69-5.80 (11, 3.78 ± 0.261).

General Description. Snout shorter than eye, with oblique profile and convex section; anterior nostril a short erect tube, reaching posterior edge of upper lip when depressed, with oblique, forwardly directed orifice lacking dermal processes; posterior nostril a transverse oval pore, just before level of anterior edge of orbit; eyes large, dorsolateral, with narrow interorbital space; postorbital region with subhorizontal profile and median longitudinal groove; dorsal axial musculature covering nearly all cranial roof; mouth moderately oblique, jaws subequal, with posterior angle below anterior third of eye; upper lip width half or equalling that of lateral preorbital area; branchiostegal membrane attached along entire lateral margin of isthmus from immediately anterior to pectoral origin; tongue broad, truncate, with slight median emargination and rounded corners.

Otoliths. Sagitta almost square, lower anterior corner right-angled, dorsal edge markedly convex, lower and anterior edges more or less straight with slight emargination before rounded lower posterior corner, posterior edge straight or emarginate; at standard length 39-40 mm, sagitta 1.1-1.25 mm high by 1.2 mm long.

Teeth. Upper and lower jaws with bands of small caniniform teeth, outer and inner rows enlarged. Pharyngeal teeth caniniform.

Fins. For method of counting, see MILLER (1968). Abbreviations used are I.o.M., Isle of Man (Port Erin) material; W.Ch., Western Channel (Looe), and Adr., Adriatic (Split). Values give are most frequent number(s), overall range in parentheses, and for each locality

are number of observations, mean, standard error, and results of t-test, when differences between localities are probably significant ⁽¹⁾, significant ⁽²⁾, or highly significant ⁽³⁾.

(i) First dorsal fin VI (V-VI) (I.o.M.: 100, 5.99 ± 0.010 ; W. Ch.: 99, 6.00).

(ii) Second dorsal fin I/9 (7-10) (I.o.M. : 101, 8.97 ± 0.022 , W. Ch.²; W.Ch. : 90, 9.08 ± 0.042 , I.o.M.²).

(iii) Anal fin I/9 (8-10) (I.o.M. : 85, 8.93 ± 0.031 , W.Ch.³, Adr.¹; W.Ch. : 87, 9.08 ± 0.034 , I.o.M.³, Adr.³).

(iv) Pectoral fin 18-19 (16-20) (I.o.M. : 200, 18.03 ± 0.041 , W. Ch.³; W.Ch. : 180, 18.41 ± 0.043 , I.o.M.³, Adr.³).

(v) Caudal fin (branched rays) 11-12.

(vi) Pelvic fin I/5 + I/5.

Fin-bases and lengths in relation to standard length given above (see Body Proportions). First dorsal fin arises opposite anterior quarter of pectoral fin, last ray well before vertical of pectoral fin tip; interdorsal space about two-thirds membranous, total length (between last ray of first dorsal and first ray of second dorsal fin) 8.33-11.35 (mean 9.90) in standard length. First dorsal rays not reaching origin of second dorsal fin, except in adult males where D_1 IV-VI may overlap D_2 I-1 when depressed. Second dorsal fin commences very slightly in advance of anal fin-origin, with last ray above end of anal fin-base; posterior tip reaching two-thirds to three-quarters of distance from second dorsal base to upper origin of caudal fin. Anal fin commences slightly behind origin of second dorsal fin, with last ray below that of latter; posterior tip reaching about half to five-eighths of distance between anal base to lower origin of caudal fin. Caudal fin rounded, shorter than head. Pectoral fin extending back to below end of posterior membrane of first dorsal fin, uppermost rays not separated from fin membrane. Pelvic fins completely united to form disc, with edge of anterior membrane smooth to slightly crenate, but not villose; posterior margin of disc rounded, short of anus or reaching base of genital papilla. Breeding males with rows of small white "nuptial warts" along inner faces of pectoral rays (PETERSEN, 1917, fig. 1).

Scales. Ctenoid on body; not present on head, predorsal area before line from upper origin of pectoral fin to base of D_1 III-VI,

or on breast. Numbers in lateral series (Isle of Man) 39-42 (36-43) (6+, 40.03 ± 0.188 , Adr.³).

Vertebrae. 30 (30-31), including urostyle (I.o.M. : 99, 30.10 ± 0.010 , W.Ch.¹; W.Ch. : 90, 30.07 ± 0.026 , W.Ch.¹, Adr.¹).

Colouration. Both sexes: in life, yellowish olive, with coarse dark brown reticulation following scale edges above lateral midline; four very conspicuous pale saddles across back to lateral midline on each side, at origin of first dorsal fin, origin and end of second dorsal fin, and middle of caudal peduncle; superior origin of caudal fin similarly pale; lateral midline with four spots, corresponding with saddles: first below origin of first dorsal fin usually single, vertically elongate, sometimes to near ventral midline; other spots double and tend to be elongate ventrally; end of caudal peduncle with short horizontal bar more or less expanded vertically at origin of caudal fin; traces of smaller spots between double spots. On head, first saddle intergrades with paler postorbital area; oblique lateral preorbital bar crosses lips to meet fellow across chin, but no intense mental spot; large triangular dark suborbital mark from orbit to behind angle of jaws; faint anterior vertical and upper horizontal opercular marks, latter ending posteriorly in more intense spot at upper end of pectoral lobe; branchiostegal membrane and breast with numerous melanophores (from standard length of about 20 mm, developed first on breast). First dorsal fin with two oblique rows of large intense black spots with single spot on posterior membrane; above and parallel to these, a rose-pink to reddish orange band, sometimes with melanophores anteriorly and posteriorly. Second dorsal fin with one complete row of black spots, surmounting short row in anterior corner (to $3/4$ to $4/6$ interradi al membrane); and a few dark spots above posterior end of complete row, frequently forming second complete row of dots, much fainter than lower one and incorporated into most proximal of three oblique rosy bands across fin. Anal fin and pelvic disc greyish, with melanophores at base of anal rays in ventral midline. Pectoral fin with small oblique dark mark across upper origin to base of usually sixth ray; rest of fin hyaline. Adult male: colouration more intense; distal parts of first dorsal rays somewhat dusky; darker branchiostegal membrane, breast, pelvic disc and anal fin, last going dusky especially towards edge; short vertical yellow to ochreous markings on sides below lateral midline.

Lateral Line System. (Fig. 3; see also FAGE, 1914, fig. 5). Terminology used is that of SANZO (1911); numbers of papillae in each row given in parentheses.

(a) Cephalic canals. Anterior and posterior oculoscapular and preopercular canals present, with pores σ , λ , κ , ω , α and ρ ; ρ' and ρ'' ; and γ , δ , ε respectively.

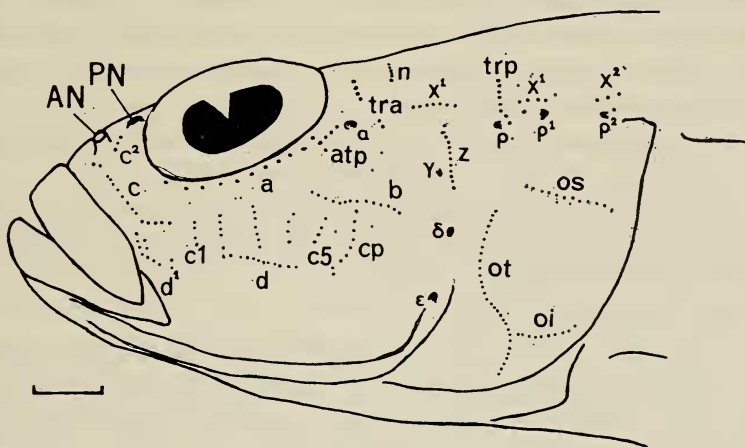


Fig. 3 - *Pomatoschistus pictus pictus*, lateral-line sensory papillae and canal-pores (cross-hatched) of head in female, 38.5 + 7.8 mm, trawled off Port Erin, 5th Nov.. 1959 A.N, anterior nostril; PN, posterior nostril; other lettering as in text. Scale 1 mm,

(b) Sensory papillae. (i) Preorbital. Median series in three rows, posteromedian r (2 papillae), s (1-2), and anterior s^3 (1-2). Lateral series with ascending row c (10-14), and c^2 lateral to nostrils (8-9).

(ii) Suborbital. Infraorbital row a consisting of short section (2-3) from pore α , one transverse row atp (2-4), and anterior section (8-17) following lower edge of orbit to end below or just in advance of anterior edge of pupil. Longitudinal row b to below posterior border of orbit, well separated from pore δ . Below level of row b , usually six transverse rows (c 1-5 and cp) in series along cheek from above angle of jaw to below middle of row b ; $c1$ (2-4), $c2$ (1-4), $c3$ (1-7), $c4$ (3-6), $c5$ (3-4) and cp (6-11). Longitudinal row d with doubled anterior oblique d^1 (9-15) above angle of jaw, and posterior horizontal part (5-12) more or less separated from d^1 and not meeting cp .

(iii) Preopercular-mandibular. External row *e* and internal row *i* both divided into prearticular (*e*, 14-20; *i*, 18-25) and postarticular (*e* 25-37; *i* 21-27) sections by gap in region of lower jaw articulation. Mental row *f* (2-3).

(iv) Oculoscapular. Anterior transverse series *tra* with upper section (2-4) above and behind pore α and lower section (1-2) behind latter. Row α (4-12) ending behind pore γ . Longitudinal row α^1 divided by posterior transverse row *trp* (5-9) into anterior (4-9) and posterior (2-5) sections; below latter, row *q* (1-2) before pore ρ^1 . Posterior longitudinal row α^2 (3-5) over one papilla at pore ρ^2 representing row *y*. Axillary rows *as*, as^1 , as^2 , *la* and la^2 present.

(v) Opercular. Transverse row *ot* (19-28), superior longitudinal row *os* (8-15), and inferior longitudinal row *oi* (8-13).

(vi) Anterior dorsal (Occipital). Anterior transverse row *n* (2-6). Longitudinal rows *g* (3-6) and *m* (4-5). Row *o* (usually 1, rarely 2-3). Longitudinal row *h* (about 10-13).

(vii) Interorbital. Absent.

(viii) Trunk, and (ix) Caudal. Several anterior ventral series *lt*; row *lv* opposite genital papilla; median series *ltm* of short vertical rows along lateral midline, in anterior angle of alternate scales until below anterior half of second dorsal fin, when rows occur on successive (larger) scales to end of caudal peduncle; dorsal row *ld* and ld^1 opposite base of first dorsal fin. Caudal fin with three longitudinal rows.

Biology. The typical subspecies of *Pomatoschistus pictus* is of southern boreal-northern lusitanian distribution in the eastern Atlantic. The northern limit of distribution appears to be at Trondheimfjord (COLLETT, 1902), since a much more northerly record from Tromsø ($69\frac{1}{2}^{\circ}$ N) given by DUNCKER (1928) was omitted by this author from a later work (DUNCKER, 1950) and has never been corroborated (ANDERSON, 1942). From Trondheimfjord, the species is known at many localities along the Norwegian south-western and Swedish Skagerrak coasts (MALM, 1865, 1877; COLLETT, 1875a, 1902) and as far south into the Kattegat as the Belt Seas and Öresund (WINTHER, 1877; PETERSEN, 1919, BRUUN and PFAFF, 1950, CURRY-LINDAHL, 1961), although adults have not been taken in the southern Kattegat (DUNCKER, 1928). This goby does not penetrate into the Baltic Sea (DUNCKER, 1928, 1960). In the southern North Sea, the subspecies is reputedly uncommon, although found off Heligoland (KÜNNE, 1934; DUNCKER, 1960), in the

Waddensea (FONDS, 1964), and at Whitstable, in the Thames estuary (NEWELL, 1954). From north-eastern Scotland, in the Firth of Tay (ALEXANDER, 1932), Aberdour Bay (RAE & WILSON, 1956) and at Rousay, in Orkney (E. KELLOCK, personal communication), *P. p. pictus* has been found at many points along the western and southern shores of the British Isles (summarised by MILLER, 1963; RYLAND, 1969; HALLIDAY, 1969) and into the western basin of the English Channel, as far east as Lulworth (F.P. ERRINGTON, personal communication), and including the western coast of Brittany, near Roscoff (LE DANOIS, 1909, 1913; FAGE, 1914). Under another specific name (see above), DE BUEN (1923) found this species at Vigo, north-western Spain (DUNCKER, 1928) and LOZANO Y REY (1961) reported this form to be common along the northern coasts of Spain. The known distribution indicates that *P. p. pictus*, while stenohaline, tolerates annual temperature fluctuations from 4.5-14.0°C (Norway) to 10-22°C (N. Spain): rarity in the south-east North Sea may be due to low winter temperatures (3-4°C), though comparably low temperatures are also encountered in the Kattegat in winter (INTERNATIONAL COUNCIL FOR EXPLORATION OF THE SEA, 1962).

P. p. pictus is an inshore fish reported from the intertidal zone down to about 50 m (HOLT & BYRNE, 1903; DUNCKER, 1928, 1960). It has been taken on a variety of bottoms, from the muddy sand of *Zostera* beds to coarse grounds of gravel, stone, dead shells and corallines, but a preference for coarse sand or gravel seems evident (HOLT & BYRNE, 1898, 1903; LE DANOIS, 1909, 1913; DUNCKER, 1928, 1960; FRASER, 1935; JONES, 1940; HALLIDAY, 1964). Sporadic intertidal occurrence is recorded by HERDMAN & DAWSON (1902), HOLT & BYRNE (1903), ALEXANDER (1932), MOORE (1932, 1937), BRUCE et al. (1963), and HALLIDAY (1969). The species identified as *Gobius pictus* by GILTAY (1927) from brackish ditches of the Scheldt near Antwerp was in all probability *Pomatoschistus microps*, according to DUNCKER (1928).

From 1958 to 1961, a survey of gobiid fishes was undertaken by the author (MILLER, 1963b) around the southern Isle of Man (Irish Sea), whose topography, hydrography and marine fauna have been summarised by BRUCE et al. (1963). During this work, *P. p. pictus* was found to be common in Port Erin Bay from depths of 2 to 3.5 m on coarse gravel, into deeper parts on finer sandy gravel (10-20 m). Outside the bay, this goby was abundant on deposits of gravel, pebbles, dead shells and *Lithothamnion* off the Calf Island, Aldrick Bay and Bradda Head, and was also present on the sandy gravel of Bay Fine. In deeper water

off the southern tip of the Isle of Man, the species was obtained on gravel, broken shell and stones in 35 m, $2\frac{1}{2}$ miles south of Spanish Head (in 53 m) and ESE of Langness (36.5 m). At more offshore localities on the west side of the Island, *P. pictus* was dredged on shell gravel and dead shells NW of Bradda Head (40-44 m); on dead shells, stones and mud north of Calf Island, on muddy, shell gravel and shells $1\frac{3}{4}$ miles west of Bradda Head; and on stony ground west of Calf Sound (40-42 m). During late summer and early autumn, young demersal individuals were collected at the mouth of the Silver Burn estuary, Castletown, over gravel, stones, bare rock and weed, but were never captured in the estuary channel proper where low-water salinity was less than 15‰ (JONES, 1948). Although discovered by MOORE (1932, 1937) to be fairly common in pools between tide-marks at Port Erin, this species was never found there in the intertidal zone by the present author, and only once in eighteen months of shore-collecting at Poyllbrein, near Castletown (see MILLER, 1961b, for details of habitat), where a few juveniles were netted in a mid-tide rock pool on pebbles between weed-patches (27 Aug., 1959).

Elsewhere in the British Isles, the author collected ripe adults of this species at low water of a spring tide on the Gann Flats, Dale, Pembrokeshire, over silty sand with many small stones, in May, 1960. At Hannafore Point, Looe, Cornwall, in September, 1962, young *P. pictus* were taken from an upper shore pool, 4m x 2m x 30cm deep, with a bed of sand, pebbles and stones on bare rock and a flora of mainly isolated clumps of *Halidrys* (Phaeophyceae) as well *Corallina* (Rhodophyceae). This was, however, the only record among fifteen pools investigated in detail and many others cursorily examined on that stretch of coast. Two years later, in September, 1964, the area was revisited and juvenile *P. pictus* found in five of eleven pools, in two of which the species was common. Both pools were large, but relatively shallow, one at lower midtide level, with a floor of coarse sand and flat stones, edged with the algae *Lithothamnion* (Rhodophyceae), *Corallina*, and dependant *Fucus serratus* (Phaeophyceae), and the other, at upper midtide level, with flat pebbles, little weed and very numerous *Littorina littorea* L. (Gastropoda). In the latter pool, *P. pictus* formed loose groups on open areas of bottom and was much easier to hand-net than comparably sized young of *Gobius paganellus* L., more typically intertidal, which darted between the cover afforded by submerged stones. It thus seems likely that temporary colonisation of shore pools by juve-

niles of *P. pictus* fluctuates from year to year and may be correlated with success in year-class recruitment to the demersal population of adjacent sublittoral waters. Over a period of five years (1956-1961), *P. pictus* was found to occur only rarely on the shore at Morecombe, Lancashire (JONES & MILLER, 1966), despite offshore abundance on prawning beds noted in the past by FRASER (1935).

There is little published information on the diet of *P. pictus*. The gut contents of over ninety individuals from Port Erin bay examined by the author are listed in Table I. The assessment of relative importance of food items is by a "points" system, essentially volumetric, described by MILLER (1963a) and based on that discussed by HYNES (1950). The diet consists chiefly of small crustaceans and polychaetes. In view of the abundance of *P. pictus* in the area, it may be supposed that the species plays a significant role as an intermediate predator in a food web connecting microbenthos with larger predatory fish, among which the cottid *Enophrys bubalis* (Euphrasen, 1786) is known to prey on *P. pictus* (RICE, 1962).

Using material collected by the author off the Isle of Man, Dr. R.G. HALLIDAY, now of the Fisheries Research Station, St. Andrews, New Brunswick, Canada, investigated the life-history of *P. pictus* at Glasgow University in 1962-63. Maximum lengths found were $48.0 + 9.0$ mm (males) and $42.0 + 9.0$ mm (females). Sexual maturity (ripening) was reached at a minimum standard length of 23.0 mm in both sexes after the first winter of life. Duration of life is usually two year and only rarely exceeds three years as determined from scale annuli. The breeding season extends from March to July, judging from occurrence of ripe or late ripening females and males with pectoral warts. In Manx waters, ripe adults were obtained from 2-3.5 m in Port Erin Bay to 35m $2\frac{1}{2}$ miles south of Perwick Bay with no indication of an inshore spawning migration postulated by LEBOUR (1919). Their occurrence at low water of spring-tides on sand flats at Dale has already been mentioned. Sexual dimorphism, manifested in colouration, differences in body proportions, and development of pectoral nuptial warts, is described above. Territoriality and spawning behaviour, as observed by KÜNNE (1934) in aquaria at Heligoland, follows the usual gobiid pattern summarised by REESE (1964). Eggs are laid in a single-layered patch (KÜNNE, 1934, Abb. 2 & 3) subsequently guarded by the male, and have been found on various shells (*Pecten*, *Glycimeris*, *Patella*) inside Plymouth Sound at depths of 5.5 to 11 m by HOLT & BYRNE

(1898), BALFOUR-BROWN (1903) and LEBOUR (1920). The eggs are pyriform, 0.8 mm high by 0.65 mm broad (LEBOUR, 1920) and hatch in 11 to 12 days at water temperatures of 13-14°C (KÜNNE, 1934). Fecundity varied from 311 to 1544 mature oocytes in Manx females of 26.5 to 42.0 mm standard length. The postlarvae, 2.7-3.0 mm on hatching, are described and illustrated at various stages to metamorphosis by PETERSEN (1919) and LEBOUR (1919). Postlarvae and juveniles were caught by tow-net or young fish trawl down to at least 18 m in Plymouth Sound and adjacent bays (LEBOUR, 1919).

***Pomatoschistus pictus adriaticus* subsp. nov.**

(Pl. I, 2)

Gobius affinis Kolombatovic, 1891: 16 (Split) (non *Gobius affinis* Eichwald, 1831: 75 (Balkhan Bay, Caspian Sea)).

Gobius pictus Malm: Ninni, 1938: 21, 65, 167, Tav. VI, d, e; Soljan, 1948: 227, 377; 1963: 227, 386.

Pomatoschistus pictus (Malm): Iljin, 1927: 132, 138; Slastenenko, 1939: 113; Svetovidov, 1964: 418; Bini, 1969: 79.

Nomenclature. A new name, *adriaticus*, has been proposed for this subspecies, since *Gobius affinis* Kolombatovic, 1891 is preoccupied by *Gobius affinis* Eichwald, 1831 (= *Gobius melanostomus* Pallas, 1814).

Material. Four males, 37.5 + 8.0 to 41.0 + 9.0 mm, and five females, 33.5 + 7.5 to 37.0 + d. mm, from Split, Yugoslavia (NHMW 28663/670); five males, 33.8 + 7.0 to 40.0 + 8.5 mm, and one female, 34.0 + 7.5 mm, from Vranjic, near Split (NHMW 28671/676). These specimens are regarded as syntypes of *Gobius affinis* Kolombatovic (P. KÄHSBAUER, personal communication). Also two males, 36.0 + 8.0 and 37.0 + 7.5 mm, and two females, 31.5 + 6.5 and 35.0 + 6.5 mm, from Punta Olmi, Muggia, near Trieste, Italy, 18th May 1969 (Dr. H. Bath), and five females, 31.0 + 6.5 to 34.5 + 7.0 mm, from Erdek, in the Sea of Marmora, Turkey, 28th May 1969 (Dr. H. Bath).

Body Proportions. Data from Split material presented as for typical subspecies (*pict.*).

(a) In standard length,

(i) head length, in males 3.64-4.00 (9, 3.83 ± 0.026 , *pict.*³), females 3.75-4.30 (6, 3.99 ± 0.077).

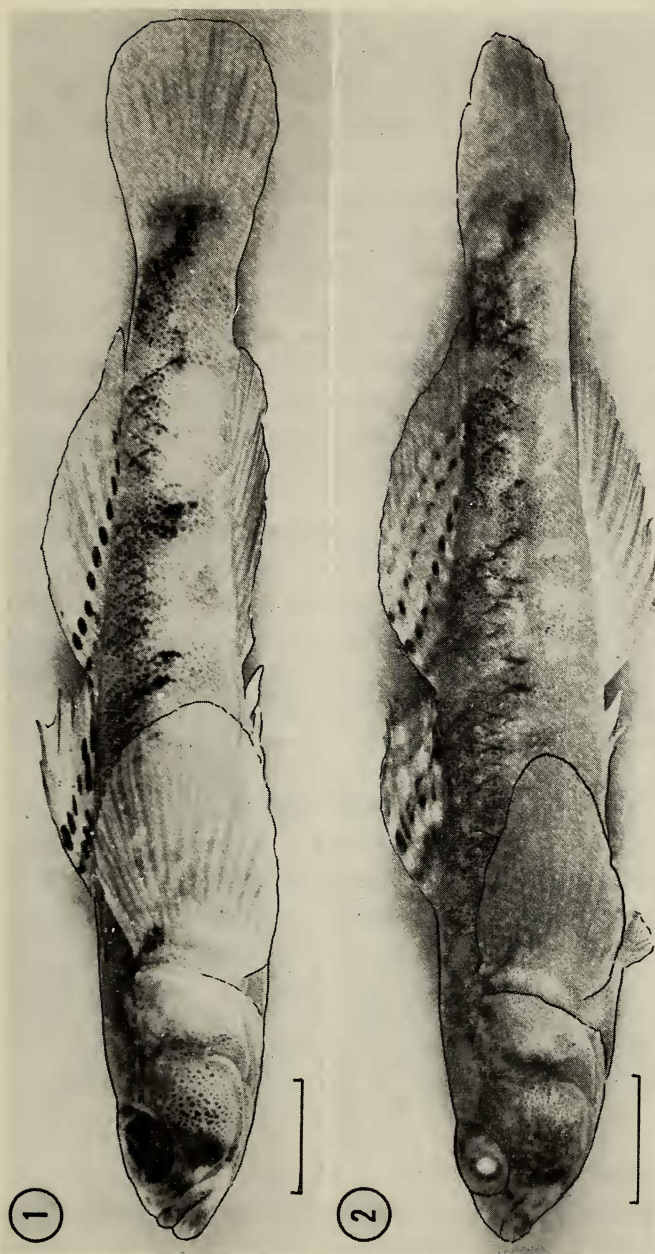


Plate I

1. *Pomatoschistus pictus pictus*, male 45.0 + 9.25 mm, from Port Erin Bay, Isle of Man, 26th July, 1962.

2. *P. p. adriaticus*, male, 44.0 + 9.0 mm, from Vranjic, Yugoslavia (NHMW 28671/676, part)

Note that in both fishes, which were selected to show characteristic patterning of the second dorsal fin, the body has become bent post mortem and consequently focus in the photographs deteriorates towards head and tail.

Scale 5 mm.

(ii) head width, in males 6.82-8.02 (9, 7.37 ± 0.113), females 6. 98-7.44 (6, 7.20 ± 0.072).

(iii) distance from snout to first dorsal fin, in males 2.75-3.05 (9, 2.88 ± 0.034), females 2.56-2.82 (6, 2.70 ± 0.040 , s.d.²).

(iv) distance from snout to second dorsal fin, in males 1.75-1.91 (9, 1.81 ± 0.015 , pict.²), females 1.71-1.75 (6, 1.73 ± 0.007 , s.d.³, pict.³).

(v) distance from snout to anus, in males 1.84-2.13 (9, 1.97 ± 0.030), females 1.78-1.83 (6, 1.80 ± 0.007 , s.d.³, pict.³).

(vi) distance from snout to anal fin, in males 1.71-1.88 (9, 1.77 ± 0.018), females 1.64-1.69 (6, 1.66 ± 0.008 , s.d.³, pict.³).

(vii) distance from snout to pelvic fin, in males 3.18-3.65 (9, 3.41 ± 0.053 , pict.¹), females 3.23-3.52 (6, 3.35 ± 0.040 , pict.¹).

(viii) caudal peduncle length, in males 3.45-3.95 (9, 3.68 ± 0.049 , pict.³), females 3.36-3.83 (6, 3.61 ± 0.077 , pict.³).

(ix) first dorsal fin-base, in males 8.86-10.00 (9, 9.45 ± 0.138), females 8.60-10.00 (6, 9.19 ± 0.210).

(x) second dorsal fin-base, in males 4.46-5.33 (9, 4.75 ± 0.093) females 4.79-5.67 (6, 5.32 ± 0.138 , s.d.²).

(xi) anal fin-base, in males 4.69-5.63 (9, 5.16 ± 0.122), females 5.75-6.49 (6, 6.02 ± 0.109 , s.d.³, pict.²).

(xii) caudal fin length, in males 4.41-4.88 (9, 4.70 ± 0.049 , pict.²), females 4.47-4.60 (3, 4.53 ± 0.083 , s.d.¹, pict.³).

(xiii) pectoral fin length, in males 4.08-4.69 (9, 4.34 ± 0.067), females 4.16-5.00 (5, 4.50 ± 0.146).

(xiv) pelvic fin length, in males 4.00-4.48 (9, 4.25 ± 0.057), females 3.94-4.80 (6, 4.22 ± 0.132).

(xv) pelvic fin origin to anus, in males 4.20-4.93 (9, 4.53 ± 0.069), females 3.90-4.23 (6, 4.04 ± 0.048 , s.d.³, pict.³).

(xvi) body depth at origin of pelvic fin, in males 4.94-6.31 (9, 5.60 ± 0.135 , pict.¹), females 4.63-5.23 (6, 5.09 ± 0.093 , s.d.², pict.³).

(xvii) body depth at origin of anal fin, in males 5.57-6.50 (9, 6.09 ± 0.105 , pict.³), females 4.80-6.20 (6, 5.89 ± 0.221 , pict.³).

(xviii) caudal peduncle depth, in males 8.91-11.00 (9, 9.51 ± 0.202 , pict.³), in females 9.60-11.17 (6, 10.43 ± 0.247 , s.d.¹, pict.³).

(b) In caudal peduncle length,

(i) caudal peduncle depth, in males 2.38-3.11 (9, 2.59 ± 0.074), females 2.62-3.24 (6, 2.90 ± 0.087 , s.d.¹).

(c) In distance from pelvic origin to anus,

(i) pelvic fin length, in males 0.86-0.98 (9, 0.94 ± 0.013), females 1.00-1.14 (6, 1.05 ± 0.020 , s.d.³, pict.³).

(d) In head length,

(i) snouth length, in males 4.29-6.06 (9, 5.07 ± 0.166), females 4.78-5.75 (6, 5.09 ± 0.145).

(ii) eye diameter, in males 2.83-3.57 (9, 3.28 ± 0.083), females 2.61-3.17 (6, 2.90 ± 0.074 , s.d.²).

(iii) postorbital length, in males 1.90-2.25 (9, 2.06 ± 0.041), females 1.89-2.15 (6, 1.99 ± 0.043).

(iv) cheek depth, in males 4.08-6.00 (9, 4.83 ± 0.198 , pict.¹), females 4.30-6.13 (6, 5.57 ± 0.262 , s.d.¹, pict.³).

(v) head width, in males 1.78-2.15 (9, 1.93 ± 0.039 , pict.²), females 1.62-1.92 (6, 1.82 ± 0.047).

(e) In eye diameter,

(i) interorbital width, in males 2.90-5.00 (8, 3.41 ± 0.255), females 2.90-5.80 (6, 3.50 ± 0.463).

Selected values for Muggia and Erdek material are, in standard length, head length 3.62-4.06, distance from tip of snout to origin of second dorsal fin 1.74-2.00, to anus 1.80-2.06, caudal peduncle length 3.36-4.08, and distance from pelvic origin to anus 3.88-4.64.

General Description. Otherwise as for *P.p. pictus*.

Otoliths. As *P.p. pictus*.

Teeth. As *P.p. pictus*.

Fins. Data from Split material presented as for typical subspecies, which see for abbreviations.

(i) First dorsal fin VI.

(ii) Second dorsal fin I/9 (8-9) (15, 8.80 ± 0.110).

(iii) Anal fin I/8-9 (8-9) (15, 8.60 ± 0.131 , I.o.M.¹, W.Ch.³).

(iv) Pectoral fin 18 (17-19) (23, 17.96 ± 0.099 , W. Ch.³).

(v) Caudal fin (branched rays) 11-12.

(vi) Pelvic fin I/5 $\pm$ I/5.

Muggia and Erdek: first dorsal fin VI (9 individuals); second dorsal fin I/8-9 (8 : 2 individuals; 9 : 7); anal fin I/8-9 (8 : 4; 9 : 5); pectoral fin 17-19 (17 : 1 observation; 18 : 12; 19 : 5).

Fin-bases and lengths in relation to standard length given above (see Body Proportions). Muggia and Erdek: anal fin base 6.03-6.61 in standard length.

Otherwise as for *P.p. pictus*. Nuptial warts present on pectoral fin in adult male.

Scales. Distributed as in *P.p. pictus*. Number in lateral series (Split) 34-40 (24, 37.33 ± 0.339 , I.o.M.³). Muggia and Erdek: 35-40 scales in lateral series (35: 1 observation; 36: 2; 37: 1; 38: 1; 39: 5; 40: 3).

Vertebrae. 30, including urostyle (Split) (13, 30, W. Ch.¹).

Colouration. As for *P.p. pictus*, but body reticulation following scale edges somewhat coarser, since there tend to be fewer scales in lateral series (Plate I). First dorsal fin with darker band in distal part of fin; second dorsal fin nearly always with second complete row of dark spots usually fainter than lower complete row; sometimes traces of third more distal row above. Dorsal fin spots often small, inconspicuous. Breast in female may be incompletely pigmented.

Lateral Line System. As described for *P. pictus*, but sensory papillae are not well preserved in any of the syntypes of *G. affinis* or in the other material and consequently it was impossible to count numbers in particular rows.

Biology. Known from the Adriatic Sea in the vicinity of Split on the Dalmatian coast and at Muggia on the Gulf of Trieste, and also from the Sea of Marmora at Erdek in Anatolia. One of the *P. pictus* illustrated by NINNI (1938) from the Venetian Lagoon seems to be correctly identified (Plate VI, d & e), and may thus belong to this subspecies. The habitat and bionomics of the goby at Split have not been fully described, although KOLOMBATOVIC (1891) noted its presence inshore, especially near outflow of fresh water. NINNI (1938) records *G. pictus* from the vicinity of *Zostera* beds but includes at least one other *Pomatoschistus* species within this identification. Recently, Dr. H. BATH found that this subspecies was of inshore occurrence at both Muggia and Erdek. At the former locality, it was found in about 1 m depth among stones overgrown with algae, while near Erdek the goby was netted in sandy shallows with little vegetation near the mouth of a stream. The annual surface sea-temperature regime experienced

in the Adriatic varies from about 9° to 24°C (Gulf of Venice) and 12° to 24°C (middle Adriatic), while in the Sea of Marmora the range of monthly means is from 7.5° to 24.2°C (KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT, 1957). Maximum size among the material studied was 41.0 + 9.0 mm (males) and 37.0 + d mm (females). SOLJAN (1948, 1963) also records 51 mm as maximum length. Sexual dimorphism in body proportions is noted above (see "subspecies within *Pomatoschistus pictus*"). Pectoral warts are developed as in the typical subspecies.

DISCUSSION

About a quarter of the approximately forty-five Mediterranean gobiid species extend in geographical range to at least the southern edge of the north-eastern Atlantic cold-temperate boreal region (defined by EKMAN, 1953). As revealed by present records of distribution, *Pomatoschistus pictus* seems to be unique among these fishes in having discrete Atlantic and Mediterranean (Adriatic and Marmora) populations, well separated geographically from each other by the intervening western basin of the Mediterranean and south-western seas of the Iberian Peninsula. This fact was noted by NINNI (1938) who first recorded *P. pictus* from the Adriatic. Earlier, PAOLUCCI (1908) indicated certain similarities between the Adriatic fish-fauna and that of northern European seas, and postulated the existence in the Pliocene of a direct connexion between the Adriatic and the North or Baltic Seas. There seems little evidence to support this view against that favouring a general late Pleistocene continuity of boreal marine faunas between the Mediterranean and Atlantic in a much cooler marine environment. The existence of *P. pictus* in at least the Adriatic and the Sea of Marmora may thus be accounted for in terms of the Pleistocene history of the Mediterranean. Following the warm Riss/Würm interglacial (Eutyrrenian) period (105,000 to 75,000 years ago), sea-temperatures of the Mediterranean, during the Middle and Late Würm glaciation (50,000 to 18,000 years ago), in at least the western basin, fell no less than 5-7°C below their present range (EMILIANI, 1955), and to about 5°C lower than the mean summer value now found in the eastern Mediterranean (BUTZER, 1961). Under such conditions, a cold temperate marine fauna of Atlantic immigrants, derived from that displaced southwards into present Lusitanian waters, became established in the Mediterranean (EKMAN, 1953; PERES, 1967). Despite a fall in sea level, which exposed

the northern part of the present Adriatic basin (VAN STRAATEN, 1965) and the present Dardanelles and Bosphorus, it is not believed that the Straits of Gibraltar were closed at any time during this glacial period, and it seems unlikely (but not impossible) that connexion between western and eastern basins of the Mediterranean was interrupted (ERIKSSON, 1965). To judge from the hydrography of areas currently inhabited by *P. pictus* in the cooler temperate Atlantic, this species would have formed part of the "boreal" or "septentrional" Mediterranean fauna of Würmian times. With postglacial amelioration of the eastern Atlantic and Mediterranean marine climates, the geographical range of less eurythermal cold-temperate species, presumably including *P. pictus*, receded northwards from the Straits of Gibraltar as, concurrently, Mediterranean stocks became largely extinct. In the case of *P. pictus*, the Mediterranean subspecies may be regarded as a relict population of these anathermal events. The Atlantic and Mediterranean forms have undergone morphological divergence since their postglacial separation. The meristic differences may be partly phenotypic, caused by the influence of environmental temperatures on early development (GARSDIE, 1970), but the trend towards pattern changes in the second dorsal fin may be more significant for speciation. Courtship behaviour in gobiids (KINZER, 1960; REESE, 1964), including the genus *Pomatoschistus* (GUITEL, 1892; KÜNNE, 1934; NYMAN, 1953), involves median fin display where markings peculiar to each species play a role in species-recognition and establishment of reproductive isolation. It must also be assumed that the Mediterranean fishes have become more tolerant of a higher temperature regime than their Atlantic relatives. The habitat of *P. pictus* in the northern Adriatic and Sea of Marmora is hardly offshore, at least in May, when mean sea-surface temperature is 16.9° and 15.2°C in the areas of Muggia and Erdek respectively (KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT, 1957). If the modern discontinuity in known geographical range for *P. pictus* is a real one, and not due to inadequate collecting in the western Mediterranean, then this phenomenon raises the question of why *P. pictus* has not also survived in the north-western parts of the latter area, where February monthly mean sea-temperatures (11.7-12.5°C) are slightly cooler than those in the middle Adriatic (12-13°C), and August mean sea-temperatures (Gulf of Lions) actually cooler (20-21°C) than in the Adriatic and Marmora areas (23-24°C) where *P. pictus* is known to occur (KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT, 1957). However, collectively,

the three areas - north-western basin, northeastern Adriatic, and Sea of Marmora (and adjacent north-eastern Aegean) - represent the coldest parts of the Mediterranean region during high summer, with maximum mean (for August) not exceeding 24°C. It will be of interest to determine whether or not the geographical range of *P.p. adriaticus* is actually interrupted by this hydrographic discontinuity between Adriatic and Aegean seas.

In a wider field, there are many examples of marine invertebrates of discontinuous occurrence in Atlantic boreal and Adriatic waters (RIEDL, 1960 a, b; GAMULIN-BRIDA, 1967) although Mediterranean distribution of *P.p. adriaticus* extends beyond the latter basin. Another reason for present survival in the Adriatic and Sea of Marmora rather than in the northwestern Mediterranean may lie perhaps with the somewhat lower salinities found in these areas, closer to those of the coastal north eastern Atlantic than the rest of the Mediterranean. In the latter area, there is some indication (see above) that the species may frequent places of reduced salinity. It is tempting to compare the distribution of *P. pictus* with that of the plaice, *Platichthys flesus* (L.). This species inhabits the low arctic and temperate Atlantic as far south as the Gulf of Cadiz (LOZANO Y REY, 1960). It also occurs in the western Mediterranean and Adriatic, but is rare in the former and much more common in the Adriatic, though absent farther east (GAMULIN-BRIDA, 1967).

By contrast, two other northern marine fishes are known in the Mediterranean only from the northern part of the western basin. These are the eastern Atlantic boreal cottid *Enophrys bubalis* recorded from the Gulfs of Marseilles (COTTE, 1919) and Alassio (VINCIGUERRA, 1923), and the low arctic-amphiboreal anarhichadid *Anarhichas lupus* L. also found in the Gulf of Genoa (TORTONESE, 1958). However, knowledge of the distribution of Mediterranean gobiids is far from complete, so that future discovery of *P. pictus* in the northern part of the western basin, and perhaps in the neighbouring Atlantic waters of the Gulf of Cadiz and the Portuguese coast, would not be very surprising. An object lesson is afforded by the decapod crustacean *Nephrops norvegicus* (L.), once regarded as a glacial relict in the Mediterranean but now known to have a fairly continuous distribution from Iceland and northern Norway to the Adriatic and the Moroccan Atlantic coast, with "submergence" in bathymetric range to the south (EKMAN, 1953; DE FIGUEIREDO & THOMAS, 1967). If *P. pictus* were to be discovered in the north-western

Mediterranean, it is not impossible that such a population would be in the form of the boreal subspecies, *P.p. pictus*, rather than resemble *P.p. adriaticus*. This hypothetical occurrence could be a relatively recent extension in range by *P.p. pictus*, subsequent to subspecific differentiation and consequent upon cooling to the present day from a period of climatic optimum about 3,000 years ago (ERIKSSON, 1965). A pattern similar but not identical to this hypothesis is shown in the zoogeography of another inshore teleost, the clingfish *Lepadogaster lepadogaster* (Bonnaterre). This species occurs in the north-eastern Atlantic from Dakar to the Shetland Islands, and throughout the Mediterranean, but is divisible into two subspecies, the typical one from the latter area and an Atlantic form, *L.l. purpurea* (Briggs, 1955). The dividing line between their ranges, however, appears to be in the western basin of the Mediterranean, on the northern coast between Monaco and Cap Roux, France, rather than at the Straits of Gibraltar (BRIGGS, 1957).

To have reached the morphological stage of a subspecies in about 20,000 years does not imply an unusually rapid rate of evolution on the part of the Mediterranean *P. pictus*, but certain factors have no doubt influenced the speed of this process. Firstly, since late Pleistocene isolation of this Mediterranean stock, postglacial (Flandrian or Versilian) transgressions and increasing sea-temperatures would have provided a changing coastal environment and promoted rapid adaptive change to new conditions under heavy selection pressure in this potentially viable species. None of the three Mediterranean populations so far sampled would have been able to occupy their present recorded localities before postglacial inundation of Würmian coastal lowland. These circumstances, and the assumed geographical separation of the Atlantic and Mediterranean "isolates", satisfy most of the requirements for rapid speciation (MAYR, 1970). Secondly, the number of generations involved will have been high since *P. pictus* matures at one year old and, even in cooler Atlantic waters, rarely lives longer than two years (see "Biology" of *P.p. pictus*, above). However, any influence that generation-time may exert on rate of evolution (SIMPSON, 1953) seems to be counteracted by stabilising genetic effects of the large population size often achieved in species with short individual lifespans (MAYR, 1970). Over a period of time no greater than that elapsed since isolation of Atlantic and Mediterranean *P. pictus*, "pontic" subspecies are believed to have been produced in at least ten Mediterranean fishes which have entered the Black Sea after postglacial con-

fluence of this basin with the Mediterranean perhaps as recently as only 5,000 years ago (PUZANOW, 1967). These fish species (SVETOVIDOV, 1964) represent a wide variety of families, from the engraulid *Engraulis encrasicolus* L. (*E. e. ponticus* Aleksandrov; *E. e. maeoticus* Pusanov) to the clingfish *Apletodon microcephalus* (Brook) (*A. m. bacescui* Murgoci), but so far not the Gobiidae. The reputed Black Sea subspecies of *Pomatoschistus microps* (Kroeyer), *P. m. leopardinus* (Nordmann), is actually *P. marmoratus* (Risso) (MILLER, 1968) and, as stated above, it is not yet confirmed that *P. p. adriaticus* enters the Black Sea proper. If such differentiation is real, and genetic, high selection pressure and limited individual mobility must combine in some proportion to maintain current population differences across the species range which presumably in all cases remains continuous with Mediterranean stocks through the Sea of Marmora. The same factors may be expected to operate if *P. pictus* is found in the western Mediterranean and southern Lusitanian areas. Regional variation caused by development of ecophenotypes would of course be more quickly induced.

In gobies belonging to *Knipowitschia* Iljin, the author has recently suggested that an Adriatic representative of this Ponto-Caspian genus, *K. panizae* (Verga), is derived from Eutyrrhenian egress of Black Sea stock and may now rank as a distinct species, on morphological criteria, from present Black Sea *K. longicaudata* (Kessler) and *K. caucasica* (Berg) (MILLER, 1972). Here, speciation may have been completed within 75,000 years, again in an early maturing and short-lived group (BAIMOV, 1963; GEORGHIEV, 1966), although phenotypic divergence need not indicate the attainment of complete reproductive isolation from closest systematic neighbours (MAYR, 1970). There are, of course, examples in freshwater teleost groups of much faster speciation (LOWE-McCONNELL, 1969), notably in the African cichlid genus *Haplochromis*, in which five endemic species in Lake Nabugavo have arisen after less than 5,000 years of separation from closely related forms in the adjacent Lake Victoria (GREENWOOD, 1965).

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Table I. - Food of *Pomatoschistus pictus* trawled in Port Erin Bay, Isle of Man, February to May 1959. Number of fishes examined 92, standard lengths 21.5 to 46.0 mm. See text for method of points allotment.

Food items	Total points awarded:
POLYCHAETA	
Inc. Aphroditid <i>Harmathoe impar</i> (Johnston), Phyllodocid (inc. <i>Phyllodoce</i> sp.), Spionid (inc. <i>Polydora</i> sp.) Nereid indet., Opheliid indet.	148
CRUSTACEA	
Indet.	13
Ostracoda indet.	24
Harpacticoid Copepods indet.	43
Calanoid Copepods indet.	1
Cirripedia: appendages	1½
Leptostracan Nebaliid indet.	7½
Cumacea, inc. <i>Iphinoe trispinosa</i> (Goodsir)	70
Tanaidacea indet.	2½
Isopoda, inc. <i>Idotea neglecta</i> and Gnathiid	4
Isopoda: Epicaridean larvae	36
Amphipoda Gammaridea, inc. Haustoriid <i>Bathyporeia</i> sp., Oedicerotids (inc. <i>Pontocrates</i> sp., <i>Synchelidium</i> sp.), Atylid <i>Nototropis</i> sp., Gammarids <i>Megaluropus agilis</i> Hoeck, <i>Ceradocus</i> sp., <i>Melita</i> sp., Photid <i>Microprotopus</i> sp., Corophiids <i>Siphonocetes</i> sp., <i>Corophium crassicorne</i> Bruzelius	95
Amphipoda Caprellidea, inc. <i>Pariambus typicus</i> (Kryn.)	12
Mysidacea: Mysid <i>Gastrosaccus normani</i> Sars	15
ACARINA	
Inc. <i>Rhombognathus seahamii</i> (Hodge)	1½
MOLLUSCA	
Lamellibranchia, inc. <i>Abra</i> sp.	7½
Gastropoda indet.	1½
ECHINODERMATA	
Ophiuroidea indet.	7
Echinoidea indet. spines	1
UNIDENTIFIED MATERIAL	39½

REFERENCES

- AFLALO F.G., 1904 - British Salt-Water Fishes - 328 pp. - London: Hutchinson.
- ALEXANDER W.B., 1932 - The natural history of the Firth of Tay - *Trans. Perthsh. Soc. nat. Sci.*, 9: 35-41.
- ANDERSSON K.A., 1942 - Fiskar och Fiske i Norden - I, 540 pp. - Stockholm.
- BAGENAL T.B., 1965 - Fishes - Fauna of the Clyde Sea Area. 38 pp. - Millport: Scottish Marine Biological Association.
- BAIMOV U., 1963 - Data on the biology of the fish, *Bubyr caucasicus* - *Vest. Kav. Fil. Akad. Nauk Uz. S.S.R.* 3: 51-59.
- BAL D.V., 1940 - Some recent additions of fish eggs and larvae to the fauna of Port Erin - *Rep. mar. biol. Sta. Port Erin*, 53: 14-17.
- BALFOUR-BROWNE F., 1903 - Report on the eggs and larvae of teleostean fishes observed at Plymouth in the spring of 1902 - *J. mar. biol. Ass. U.K.*, 6: 598-616.
- BERG L.S., 1916 - Les Poissons des Eaux Douces de la Russie - Moscow.
- BINI G., 1969 - Atlante dei Pesci delle Coste Italiane - VII. 197 pp. - Roma: Mondo Sommerso.
- BRIGGS J.C., 1955 - A monograph of the clingfishes (Order Xenopterygii) - *Stanford Ichthyol. Bull.*, 6: 1-224.
- — 1957 - A new genus and two new species of eastern Atlantic clingfishes - *Co-peia*, 3: 204-208.
- BRUCE J.R., COLMAN J.S. & JONES N.S., 1963 - Marine Fauna of the Isle of Man - 307 pp. - Liverpool: Liverpool University Press.
- BRUUN A.F. & PFAFF J.R., 1950 - Fishes. - List of Danish Vertebrates, 19-60.
- BUTZER K.W., 1961 - Paleoclimatic implications of Pleistocene stratigraphy in the Mediterranean area - *Ann. New York Acad. Sci.*, 95: 449-456.
- CANTACUZENE A., 1956 - Inventaire de la faune marine de Roscoff. Poissons - *Trav. Stat. biol. Roscoff*, Suppl. 8: 67 pp.
- CAVINATO G., 1952 - Revisione dei *Gobius* della Laguna Veneta - *Arch. Oceanogr. Limnol. Roma*, 7, (2-3): 56 pp.
- CLARKE W.E. & ROEBUCK W.D., 1881 - A Handbook of the Vertebrate Fauna of Yorkshire - 149 pp. - London: Lovell Reeve.
- COLLETT R., 1875a - Bidrag til Kundskaben om Norges Gobier. - *Forh. Vid. Selsk. Christiania*, 1874: 151-179.
- — 1875b - Norges Fiskar, med Bemaerkninger om deres Udbredelse - 240 pp. - Christiania.
- — 1902 - Meddelelser om Norges Fiske i aarene 1884-1901. I - *Forh. Vid. Selsk. Christiania*, 1: 121 pp.
- COTTE J., 1919 - Un poisson nouveau pour la Méditerranée - *Bull. Inst. oceanogr. Monaco*, 355.
- CROTHERS J.H., 1966 - Dale Fort marine fauna - *Field Studies*, 2, Suppl.: 169 pp.
- CURRY-LINDAHL K., 1961 - Fiskarna i Färg. - 4th. ed.: 231 pp. Stockholm: Almqvist & Wiksell.
- DAY F., 1881 - The Fishes of Great Britain and Ireland. I, Parts 2 & 3: 65-240 - London: Williams & Norgate.
- DE BUEN F., 1923 - *Gobius* de la Península Ibérica y Baleares. Grupos *Lesueurii*, *Colonianus*, *Affinis* y *Minutus* - *Mem. Inst. Esp. Oceanogr.*, 3, (3): 121-266.
- — 1930 - Sur une collection de *Gobiinae* provenant du Maroc. Essai de synopsis des espèces de l'Europe - *Bull. Soc. Sci. nat. Maroc*, 10: 120-147.

- — 1931 - Notas a la familia Gobiidae. Observaciones sobre algunos generos y sinopsis de las especies ibéricas - *Not. Res. Inst. Esp. Oceanogr.* (2nd Ser.), **54**, 76 pp.
- DE FIGUEIREDO M.J. & THOMAS H.J., 1967 - *Nephrops norvegicus* (Linnaeus, 1758) Leach - a review - *Oceanogr. mar. Biol. Ann. Rev.*, **5**: 371-407.
- DUNCKER G., 1928 - Teleostei Physoclisti. 9. Gobiiformes - *Tierv. N. - u. Ostsee*, **12**: 121-148.
- — 1960 - Die Fische der Nordmark - 432 pp - Hamburg: Cram, De Gruyter & Co.
- EHRENBAUM E., 1905 - Eier und Larven von Fischen des Nordischen Planktons - *Nord. Plankt., Zool. Teil*, **1**: 1-206.
- EICHWALD C.E., 1831 - Zoologia Specialis quam Expositis Animalibus tum vivis, tum fossilibus potissimum Rossiae in Universum, et Poloniae in Specie, etc. - III - Vilna.
- EKMAN S., 1953 - Zoogeography of the Sea - 417 pp. - London: Sidgwick & Jackson.
- ELMHIRST R., 1925 - Faunistic notes, etc. - *Ann. Rep. Scot. mar. biol. Ass.*, 1924-25: 12-14.
- — 1926 - Notes on fishes from the Firth of Clyde - *Scot. Nat.*: 151-158.
- EMILIANI C., 1955 - Pleistocene temperature variations in the Mediterranean - *Quaternaria*, **2**: 87-98.
- ERAZI R.A.R., 1942 - Marine fishes found in the sea of Marmora and in the Bosphorus - *Rev. Fac. Sci. Univ. Istanbul*, **7B**: 103-115.
- ERIKSSON K.G., 1965 - The sediment core No. 210 from the western Mediterranean sea - *Rep. swed. Deep-Sea Exped.*, **8**: 395-594.
- FAGE L., 1914 - Sur le *Gobius minutus* Pallas et quelques formes voisines - *Bull. Soc. zool. France*, **39**: 299-314.
- — 1915 - Remarques sur l'évolution des Gobiidae, accompagnées d'un synopsis des espèces européennes - *Arch. Zool. exp. gen.*, **55**: 17-34.
- — 1918 - Shore-fishes - *Rep. Dan. Oceanogr. Exped. Medit. 1908-1910*, II, A3, 154 pp.
- FARRAN G.P., 1912 - A biological survey of Clare Island in the county of Mayo, Ireland and of the adjoining district. Part 19. Pisces - *Proc. Roy. Irish. Acad.*, **31**, 6 pp.
- — 1915 - Results of a biological survey of Blacksod Bay, Co. Mayo - *Sci. Inv. Fish. Ireland*, 1914, **3**, 72 pp.
- FONDS M., 1964 - The occurrence of *Gobius pictus* Malm and *Onos septentrionalis* Collett in the Dutch Waddensea - *Netherl. J. Sea Res.*, **2** (2): 250-257.
- FORREST H.E., 1907 - The Vertebrate Fauna of North Wales - 537 pp. - London: Witherby.
- FRASER J.H., 1935 - The fauna of the Liverpool Bay shrimping grounds and the Morecambe Bay prawning grounds as revealed by the use of a beam-trawl - *Proc. L'pool biol. Soc.*, **48**: 65-78.
- GAMULIN-BRIDA H., 1967 - The benthic fauna of the Adriatic Sea - *Oceanogr. mar. Biol. Ann. Rev.*, **5**: 535-568.
- GARSDIE E.T., 1970 - Structural responses in KINNE, O. (Ed), *Marine Ecology*, I, Environmental Factors, Pt 1, Ch. 3: 561-573.
- GEORGHIEV J.M., 1966 - Composition d'espèce et caractéristique des Gobiides (Pisces) en Bulgaria - *Izv. nauchnoizsl. Inst. Rib. Stop. Okeanogr. Varna.*, **7**: 159-228.

- GILTAY L., 1927 - Sur la decouverte d'une espèce de « *Gobius* » nouvelle pour la Belgique (« *Gobius pictus* » Malm) et sur les conditions éthologiques de son habitat - *Bull. Acad. Belg.* (5th Ser.), **13**: 267-283.
- GREENWOOD P.H., 1965 - The cichlid fishes of Lake Nabugabo, Uganda - *Bull. Brit. Mus. (Nat. Hist.)*, *Zool.*, **12**: 315-357.
- GUITEL F., 1892 - Observations sur les moeurs du *Gobius minutus* - *Arch. Zool. exp. gen.* (2), **10**: 499-555.
- GÜNTHER A., 1861 - Catalogue of the Acanthopterygian Fishes in the Collection of the British Museum - III, 586 pp., London.
- — 1867 - Additions to the British fauna - *Ann. Mag. nat. Hist.* (3), **20**: 288-291.
- HALLIDAY R.G., 1964 - The painted goby in the Clyde Sea Area - *Glasg. Nat.*, **9**, (7): 377.
- — 1969 - Rare fishes from the Clyde Sea area - *J. nat. Hist.*, **9**: 309-320.
- HANSEN H.J., 1883 - Fiske - *Zool. Danica*, **2**: 27-126.
- HANSSON C.A., 1881 - Till Kännedomen om norra Bohusläns vertebratfauna - *Oefvers. K. Vet. Akad. Förh.*, *Stockholm*, **37**, (4): 19-22.
- HEINCKE F., 1880 - Die Gobiidae und Syngnathidae der Ostsee nebst biologischen Bemerkungen - *Arch. Naturg.*, **46**: 301-354.
- HERDMAN W.A. & DAWSON R.A., 1902 - Fishes and fisheries of the Irish Sea - *Lancs. Sea-fish. Mem.*, **2**: 98 pp.
- HOLT E.W.L. & BYRNE L.W., 1898 - Notes on the reproduction of teleostean fishes in the southwestern district - *J. mar. biol. Ass. U.K.*, **5**: 333-340.
- — 1903 - The British and Irish Gobies - *Rep. Sea Inl. Fish. Ireland*, 1901, Part 2: 37-66.
- HYNES H.B.N., 1950 - The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes - *J. anim. Ecol.*, **19**: 36-58.
- ILJIN B.S., 1927 - Table determinative des Gobiidae des Mers Noire et d'Azov. Information préliminaire - *Abh. Wiss. Fisch-Exped. Asow. Schwarz. Meer*, **II**: 128-143.
- — 1930 - Le système des Gobiides - *Trab. Inst. Esp. Oceanogr.*, **2**, 63 pp.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1961 - International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology. - 176 pp. - London: International Trust for Zoological Nomenclature.
- JENKINS J.T., 1936 - The Fishes of the British Isles - (2nd ed.) - 408 pp. - London: Warne.
- JONES N.S., 1940 - The distribution of the marine fauna and bottom-deposits off Port Erin - *Trans. L'pool biol. Soc.*, **53**: 1-34.
- — 1948 - The ecology of the amphipoda of the south of the Isle of Man - *J. mar. biol. Ass. U.K.*, **27**: 400-439.
- JONES D. & MILLER P.J., 1966 - Seasonal migrations of the common goby, *Pomatoschistus microps* (Kroeyer), in Morecambe Bay and elsewhere - *Hydrobiologia*, **27**: 515-528.
- KINZER J., 1960 - Zur Ethologie und Biologie der Gobiiden, unter besonderer Berücksichtigung der Schwarzgrundel *Gobius jozo* L. - *Zool. Beitr.*, **6**: 207-290.
- KOLOMBATOVIC G., 1891 - Glamoči (Gobii) Spljetskog Pomorskog Okruzja u Dalmaciji - 29 pp. - Split.
- KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT, 1957 - Middelandse Zee. Oceanografische en Meteorologische Gegevens - 91 pp. - S-Gravenhage: Staatsdrukkerij.

- KROEYER H., 1838 - Danmarks Fiske. I - 616 pp. - Copenhagen: Triers.
- KÜNNE C., 1934 - Über das Laichgeschäft der Bunten Grundel im Aquarium - *Bl. Aquar. Terrarien*., **45**: 350-352.
- LEBOUR M.V., 1919 - The young of the Gobiidae from the neighbourhood of Plymouth - *J. mar. biol. Ass. U.K.*, **12**: 48-80.
- 1920 - The eggs of *Gobius minutus*, *pictus*, and *microps* - *J. mar. biol. Ass. U.K.*, **12**: 253-260.
- LE DANOIS E., 1909 - Sur la présence du *Gobius pictus* Malm en France - *Bull. Soc. Zool. France*, **34**: p. 86.
- 1913 - Contribution à l'étude systématique et biologique des poissons de la Manche Occidentale - *Ann. Inst. Oceanogr. Monaco*, **5**, (5), 214 pp.
- LILLJEBORG W., 1884 - Sveriges och Norges Fiskar - I, Pt. 3: 497-782 - Uppsala: Schultz.
- LOWEL-McCONNELL R.H., 1969 - Speciation in tropical freshwater fishes - *Biol. J. Linn. Soc.*, **1**: 51-75.
- LOZANO Y REY L., 1960 - Peces fisoclistos. Part 3, Subseries Toracicos (Ordenes Eque-neiformes y Gobiformes), Pediculados y Asimetricos - *Mems R. Acad. Cienc. Madrid (Cienc. nat.)*, **14**, 615 pp.
- LYTHGOE, J. & G., 1971 - Fishes of the Sea - 320 pp. - London: Blandford.
- MALM A.W., 1865 - Ichthyologiska bidrag till Skandinavians fauna - *Forh. Skand. Naturf.*, **9**: 405-414.
- 1874 - (No title) - *Forh. Skand. Naturf.*, 11th Meeting: 380, 383-384.
- 1877 - Göteborgs och Bohusläns Fauna, Kyggradsdjuren. 674 pp. Göteborg
- MARINE BIOLOGICAL ASSOCIATION, 1931 - Plymouth Marine Fauna - 2nd Ed. - 371 pp. - Plymouth: Marine Biological Association.
- 1957 - Plymouth Marine Fauna. - 3rd Ed. - 457 pp. - Plymouth: Marine Biological Association.
- MAYR E., 1970 - Populations, Species, and Evolution - 453 pp. - Cambridge, Mass.: Harvard University Press.
- M'Coy F., 1841 - On some new or rare fish occurring on the coast of Ireland - *Ann. Mag. nat. Hist.*, (1), **6**: 402-408.
- MILLER P.J., 1961a - A preliminary account of the gobies of Liverpool Bay - *Proc. L'pool Nat. Field Club*, 1959: 12-22.
- 1961b - Age, growth, and reproduction of the rock goby, *Gobius paganellus* L., in the Isle of Man - *J. mar. biol. Ass. U.K.*, **41**: 737-769.
- 1963a - Taxonomy and biology of the genus *Lebetus* (Teleostei - Gobioidae) - *Bull. Brit. Mus. Nat. Hist., Zool.*, **10**: 205-256.
- 1963b - Studies on the Biology and Taxonomy of British Gobiid Fishes - Ph. D. Thesis, University of Liverpool, 213 pp.
- 1965 - *Relictogobius kryzhanovskii* and the penetration of Mediterranean gobies into the Black Sea - *Nature, London.*, **208**: 474-475.
- 1968 - A new species of *Pomatoschistus* (Teleostei: Gobiidae) from western Sicily - *Ann. Mus. Stor. Nat. Genova*, **77**: 221-231.
- 1972 - Gobiid fishes of Caspian genus *Knipowitschia* from the Adriatic Sea - *J. mar. biol. Ass. U.K.*, **52**: 145-160.
- MÖBIUS K. & HEINCKE F., 1883 - Die Fische der Ostsee - 206 pp. - Berlin: Parey.
- MOORE H.B., 1932 - Faunistic records for the Manx region - *Ann. Rep. mar. biol. Sta. Port Erin*, **45**: 152-159.
- 1937 - Marine Fauna of the Isle of Man - 293 pp. - Liverpool.

- MOREAU E., 1881 - Histoire Naturelle des Poissons de la France - II, pp. - Paris: Masson.
- NEWELL G.E., 1954 - The marine fauna of Whitstable - *Ann. Mag. nat. Hist.*, (12), 7: 321-350.
- NINNI E., 1938 - I *Gobius dei mari e delle acque interne d'Italia* - *Mem. R. Com. Talassogr. Ital.*, 242: 169 pp.
- NORMAN J.R., 1927 - Zoological results of the Cambridge Expedition to the Suez Canal, 1924. XXV. Report on the fishes - *Trans. Zool. Soc. London.*, 22: 375-390.
- NYMAN K.J., 1953 - Observations on the behaviour of *Gobius microps* - *Acta Soc. Faun. Flor. Fenn.*, 69, (5), 11 pp.
- OTTERSTROEM C.V., 1912 - Fisk. I. Pigfinnefisk - *Danmarks Fauna*, II. Koebenhavn: Gads.
- PALLAS P.S., 1814 - Zoographia Rosso-Asiatica. - III. - Petropoli.
- PAOLUCCI C., 1908 - Sulla ittiofauna adriatica e particolarmente sulla *Clupea papalina* Bp - Ancona. [Not seen; quoted by NINNI, 1938].
- PERES J.M., 1967 - The Mediterranean benthos - *Oceanogr. mar. Biol. Ann. Rev.*, 5: 449-533.
- PETERSEN C.G.J., 1917 - On the development of our common gobies (*Gobius*) from the egg to the adult stages etc. - *Rep. Dan. Biol. Sta.*, 24: 3-16.
- — 1919 - Our gobies (Gobiidae). From the egg to the adult stages - *Rep. Dan. Biol. Sta.*, 26: 47-66.
- PUSANOW I., 1967 - Über die sukzessiven Stadien der Mediterranisation des Schwarzen Meeres - *Intern. Rev. Hydrobiol.*, 52: 219-236.
- RAE B.B. & WILSON E., 1956 - Rare and exotic fishes recorded in Scotland during 1954 - *Scot. Nat.*, 68: 23-38.
- REESE E.S., 1964 - Ethology and marine zoology - *Oceanogr. Mar. Biol. Ann. Rev.*, 2: 455-488.
- RICE A.L., 1962 - The food of the sea scorpion *Acanthocottus bubalis* (Teleostei-Scleroparei) in Manx waters - *Proc. zool. Soc. Lond.*, 138: 295-303.
- RIEDL R., 1960a - Über einige nordatlantische und mediterrane *Nematoderma*-Funde - *Zool. Anz.*, 165: 232-248.
- — 1960b - Neue nordatlantische Formen von adriatischen Schlammböden - *Zool. Anz.*, 165: 297-311.
- RISSEO A., 1810 - Ichthyologie de Nice, ou Histoire Naturelle des Poissons du Departement des Alpes Maritimes - 388 pp. - Paris: Schoell.
- RYLAND J.S., 1969 - Some shore fishes from Galway Bay - *Irish. Nat. J.*, 16, (5): 127-131.
- SANZO L., 1911 - Distribuzione delle papille cutanee (organi ciatiformi) e suo valore sistematico nei Gobi - *Mitth. zool. Sta. Neapel*, 20: 249-328.
- SIMPSON G.G., 1953 - The Major Features of Evolution - 434 pp. - New York: Columbia University Press.
- SLASTENENKO E.P., 1939 - Les poissons de la Mer Noire et de la Mer d'Azov - *Ann. Sci. Univ. Jassy*, 25, (1), 196 pp.
- SMITT F.A., 1892 - A History of Scandinavian Fishes - Part 1 - 566 pp. - Stockholm.
- SOLJAN T., 1948 - Ribe Jadrana - 437 pp. - Zagreb: Nakladni Zavod Hrvatske.
- — 1963 - Fishes of the Adriatic - 428 pp. - Belgrade: Nolit.
- SÖZER F., 1941 - Türkiye gobiidleri. Les gobiidés de la Turquie - *Rev. Fac. Sci. Univ. Istanbul*, 6: 128-169.
- SVETOVIDOV A.N., 1964 - Fishes of the Black Sea - 550 pp. - Moscow: Academy of Sciences of the USSR. (In Russian.).

- TORTONESE E., 1958 - Primo ritrovamento di *Anarhichas lupus* (L.) (Pisces) nel Mediterraneo (Golfo di Genova) - *Doriana*, 2, 94, 4 pp.
- VALENCIENNES A., 1837 - Histoire Naturelle des Poissons - XII, 507 pp. - Paris: Levrault.
- VAN STRAATEN L.M.J.U., 1965 - Sedimentation in the north-western part of the Adriatic Sea - In WHITLAND, W.F. & BRADSHAW, R. (ed), Submarine Geology and Geophysics: 143-162. London: Butterworths.
- VERGA D., 1841 - Descrizione di un nuovo *Gobius* frequente nelle lagune di Comacchio, con cenni anatomici sullo stesso. - *Atti Riun. Sci. Ital., Firenze*, 3: p. 379.
- VINCIGUERRA D., 1923 - Il *Cottus bubalis* nel Golfo di Genova - *Ann. Mus. Stor. Nat. Genova*, 51: 1-6.
- WENT A.E.J., 1957 - List of Irish Fishes - 31 pp. - Dublin.
- WHEELER A.C., 1969 - The Fishes of the British Isles and North West Europe - 613 pp. - London: Macmillan.
- WILLIAMS G., 1954 - Fauna of Strangford Lough and neighbouring coasts - *Proc. Roy. Irish Acad.*, 56 (B): 29-133.
- WINTHER G.P., 1872 - Bidrag til fiskeskjaeltaendernes morphologi og udviklingshistorie - *Naturhist. Tidsskr. Kjöbenhavn*, 8: 527-544.
- — 1874 - Om de danske fiske af slaegten *Gobius* - *Naturh. Tidsskr. Kjöbenhavn* (3rd Ser.), 9: 191-226.
- — 1877 - Om de Danske fiske af slaegten *Gobius* - *Naturh. Tidsskr. Kjöbenhavn* (3rd Ser.), 11: 41-56.
- — 1879 - Prodromus ichthyologiae danicae marinae. Fortegnelse over de i de danske farvande hidtil fundne fiske - *Naturhist. Tidsskr. Kjöbenhavn*, 12: 1-68.

SUMMARY

The status of *Gobius affinis* Kolombatovic, 1891, from Split, Yugoslavia, is discussed and the species identified with *Pomatoschistus pictus* (Malm, 1865). The occurrence of this otherwise boreal species in the Adriatic Sea and also in the Sea of Marmora is confirmed. Differences in coloration, body-proportions, and meristic features between eastern Atlantic and Mediterranean *P. pictus* are assessed, and the latter distinguished as a new subspecies, *P.p. adriaticus*. The systematic characters of *P. pictus* and its subspecies are described, as well as the biology of the Atlantic form. The evolution and distribution of the new subspecies are interpreted in the light of Pleistocene and recent hydrography of the Mediterranean.

RIASSUNTO

Viene discusso lo « status » di *Gobius affinis* Kolombatovic, 1891, di Split (Jugoslavia); questa specie è riconosciuta identica a *Pomatoschistus pictus* (Malm, 1865). Risulta confermata la presenza di questa specie tipicamente boreale nell'Adriatico ed anche nel mar di Marmara. Poichè vengono rilevate differenze di colore, proporzioni corporee e caratteri meristici fra i *P. pictus* dell'Atlantico orientale e del Mediterraneo, la forma mediterranea viene distinta come sottospecie nuova, *P.p. adriaticus*. Si descrivono i caratteri sistematici di *P. pictus* e della sua sottospecie, nonché la biologia della forma atlantica. L'evoluzione e la distribuzione della nuova sottospecie sono interpretate in base all'idrografia pleistocenica e recente del Mediterraneo.